Measurement of Fumigants

Application Note 8

watchgas detection

Introduction

Fumigants are widely used for pest control by sterilizing soil before planting, and during storage and shipment of foods and other plant-derived materials such as wooden furniture and wood chips. Many seaports now require fumigation before wood-containing products can be released for overland shipment. Common fumigants include phosphine (PH3), methyl bromide (CH3Br or MeBr) and Vikane (sulfuryl fluoride, SO2F2).

Phosphine is the most-used fumigant, while methyl bromide is being phased out due to its ozonedepletion effects. But MeBr is also a pharmaceutical intermediate and will still be used for some time as a fumigant. Methyl bromide and phosphine have low exposure limits, with 8-hr ACGIH TWAs of 1 ppm and 0.3 ppm, respectively (see Table below). Typically, it is desired to measure high initial concentrations of several hundred ppm to ensure an adequate fumigation dose, followed by low concentrations after ventilation to prevent over-exposure of workers entering to transfer the goods. Fumigation during ship transport is done at lower concentrations but can last for weeks, and the crew's living quarters need to be monitored in case some fumigant leaks over from the vessel holds.

Fumigant Toxicity

	PH3	MEBR
ACGIH TWA	0.3 ppm	1.0 ppm
ACGIH STEL	1.0 ppm	
OSHA Ceiling		20 ppm
IDLH	50 ppm	250 ppm
Lethal in 45 min	500 ppm	
Lethal in 1-3 min	2000 ppm	

Phosphine (PH3) by UNI or POLI

Phosphine is a gas that is supplied either directly from a cylinder or is generated on-site from solid forms (usually aluminum phosphide or calcium phosphide) by reaction of with moisture in the air or the stomach acid of rodents. Common trade names for PH3–generating solids include Phostoxin, Agtoxin, Celphos, and Quickphos. These pellets can be placed in the fumigation area for slow release of PH3, or they can be converted more quickly using generators.

Two monitors for phosphine are available: the UNI badge-type single-gas monitor for low concentration personal protection and the POLI multi-gas monitor fitted with both low- and high-range sensors for both personal protection and ensuring adequate fumigation levels. The low-cost UNI has a battery life approaching 3 years continuous operation and therefore is convenient for both post-fumigation worker entry, and for long-term continuous shipcabin monitoring. The POLI could be fitted as a 5-gas monitor with LEL,O2,H2S/CO plus two PH3 sensors to serve both confined space entry and fumigation needs.

PH3 SENSOR	LOW RANGE	MEBR
Range	0-20 ppm	1.0 ppm
Extended Range	0-100 ppm	
Resolution	0.01 ppm	20 ppm
Detection Limit	0.05 ppm	250 ppm
Response Time	t_{90} ≤60 s	
Temp. Range	-20 to +50°C	
Warranty	2 years	

Phosphine by PID

PIDs are good for post-fumigation worker entry where PH3 concentrations are low but are not suitable for measuring high initial doses or use as a fixed PID. This is because PH3 has the unique property of forming coatings on the PID lamp, which reduces the response even when concentrations are constant. To minimize this effect, 1) keep the exposure concentrations and times as low and short as possible (<10 ppm for <1 minute or so), 2) perform frequent bump checks with calibration gas, and 3) clean the lamp if readings are low. Sometimes initial dose measurement is not needed because it is calculated from the mass of fumigant added and the volume of the chamber being treated.

Methyl Bromide (MeBr)

MeBr can be measured by PID at both high initial concentrations and low clearance concentrations. With the 10.6 eV lamp, the Correction Factor is 1.7, which gives a detection limit of about 0.05 ppm using the NEO handheld or VOXI fixed PID with standard ranges. These monitors can also measure the high initial doses of MeBr, if needed (no lamp-fogging issues occur with methyl bromide the way they do with phosphine).

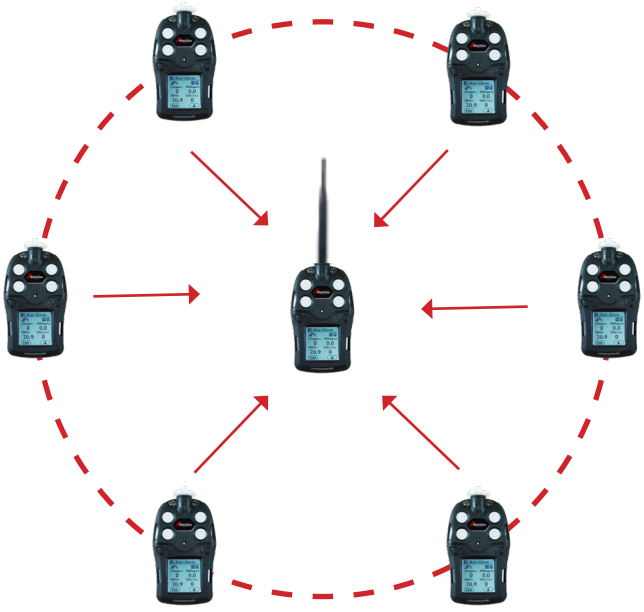
MEBR MONITOR	NEO PPM	POLI	VOXI
Portability	Handheld	Handheld	Fix-Mounted
Range	0-5000 ppm	0-2000 ppm	0-5000 ppm
Resolution	0.1 ppm	0.1 ppm	0.01 ppm
Detection Limit	0.05 ppm	0.5 ppm	0.05 ppm
Response Time	t_{90} ≤3 s	t_{90} ≤15 s	t_{90} ≤30 s
Temp. Range	-20 to +50°C	-20 to +50°C	-40 to +70°C
Run Time	24 hrs	12 hrs	continuous

POLI Multi-gas Meters for Fumigants
A POLI multi-gas monitor fitted with a PID sensor is a low-cost option for PID for MeBr. However, it is marginal in being able to measure accurately at a 1 ppm TWA, and therefore the NEO is recommended. The POLI has an advantage in that it could have both a phosphine sensor and a PID for MeBr, should both fumigants be used in the same facility, and/or fitted for confined space entry.

WatchGasSquad Wireless Systems for Perimeter Monitoring
POLI multi-gas meters with fumigant sensors can be connected in wireless networks for remote or perimeter monitoring, such as field fumigation, grain silos, and tented shipping containers. In WatchGas Squad systems with up to 8 monitors, cummunication is up to 0.5 miles (line of sight) to the head monitor, and in WatchGas Platoon systems with up to 64 units up to 2 miles distance (line of sight) to an WatchGasLink modem can be connected.

Other Fumigants: Vikane and Methylisothiocyanate
Vikane (sulfuryl fluoride), commonly used in home tenting for termites, cannot be detected by PID or a simple electrochemical sensor.

Some less-common alternative pesticides such as Metam-sodium (methylisothiocyanate) can be detected with a PID using the standard 10.6 eV lamp. The response is quite sensitive, with a correction factor of 0.6. Contact WatchGas if there is any question whether any other fumigant of interest can be measured.th



WatchGasSquad remote monitoring system

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